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Effect of river groyne structures on flow, sedimentation and erosion dynamics in rivers (Case study: the River Elbe)

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Near banks, groyne structures in rivers represent a great impact on water level, flow velocity and in particular on transport processes of dissolved and particulate contaminants. Therefore, the exchange between groyne fields and the main stream has a strong influence on sedimentation and erosion processes. In contaminated rivers, groyne fields are considered to be an effective sink of contaminants during low discharge periods because of their trapping effect whereas they are a source of contaminants during high erosive discharge conditions. The exchange of suspended sediment (contaminated) between a groyne field and a main stream is a complicated process which influences the transport and dispersion of dissolved and particulate contaminants in the river and consequently is relevant to sediments and water quality. Suspended sediment transport dynamics in main stream is quite different from that in the groyne fields because it is very much dependent on the dimensions of groyne fields and the difference between the river water level and groyne crest level. Despite its relevance for such practical applications, little research has been done on these properties. Therefore, the paper aims at analysing the effects of various groyne shapes on flow and sedimentation and erosion processes in a typical groyne field of the River Elbe using 2D numerical model. The numerical simulations are performed to investigate the sedimentation and erosion processes of fine suspended sediment transport during the extreme flood event in August 2002 over a period of 40 days. Different types of schematized groynes are tested, i.e. a standard reference groyne field in the Elbe river and groynes with different lengths and widths. The numerical results show

that the groyne dimensions and the extent of submergence variations affect the intensity of eddy shedding and recirculation in the groyne field and consequently the distribution pattern of deposited/eroded (contaminated) sediments and the sediment budget in the river reach. The mass exchange rate between the entire groyne field and the main stream at different water levels (discharges) can be determined by knowing the average residence time.